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SANTA MARGARITA PROJECT: WATER QUALITY CONTROL STUDY

Federal Water Pollution Control Administration
San Francisco, California

March 1968

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SANTA MARGARITA RIVER BASIN
CALIFORNIA

SANTA MARGARITA PROJECT

WATER QUALITY CONTROL STUDY

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DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
PACIFIC SOUTHWEST REGION SAN FRANCISCO, CALIF.
MARCH, 1968

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WATER QUALITY CONTROL STUDY

SANTA MARGARITA PROJECT

CALIFORNIA

ABSTRACT

The Santa Margarita Project will develop approximately between 11,000 and 12,000 acre-feet of water annually for military, agricultural, industrial, and municipal uses. Because the downstream beneficial uses will be few, flow regulation for water quality control will not be needed below the project reservoirs. Nutrient-rich waste flows entering the project reservoirs from upstream developments are predicted to have a significant adverse impact on the quality of the impounded waters. The most feasible plan to alleviate this problem requires transport of wastes from the Upper Basin to areas below the two proposed reservoirs. A water quality management program for the entire basin is essential to the success of this project and to the ultimate development of the basin's water resources.

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
PACIFIC SOUTHWEST REGION

SAN FRANCISCO, CALIFORNIA
MARCH 1968

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I. INTRODUCTION

PURPOSE AND SCOPE

The purpose of this report is to present (1) a determination of the need for and the value of storage for the regulation of stream flow for water quality control and (2) an evaluation of the impact of the project on water quality in the Santa Margarita River Basin, California.

The study area, located about 75 miles southeast of Los Angeles (see Figure 1), includes the coastal and inland watersheds of the basin. This study is based solely on an analysis of data available from county, state, and federal agencies. The time horizon considered, 1970 to 2020, conforms to that used by the Bureau of Reclamation in developing the project.

AUTHORITY

The study described in this report was made in accordance with provisions of the Federal Water Pollution Control Act, as amended (33 U.S. C. 466 et seq.). It also provides information as to the potential impact of the project on water quality as required by Executive Order 11288, dated July 2, 1966. Pursuant to these provisions, the Bureau of Reclamation by letter dated December 21, 1966 requested that the Federal Water Pollution Control Administration furnish them with a water quality control study for their proposed project.

ACKNOWLEDGEMENT

The cooperation and assistance of the following state and federal agencies added significantly to the value of this study:

Bureau of Reclamation, Region 3
Department of the Interior
Boulder City, Nevada

Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
Department of the Interior
Sacramento, California

Bureau of Outdoor Recreation
Department of the Interior
San Francisco, California

San Diego Regional Water Quality Control Board
State of California
San Diego, California

Office of Groundwater Resources
Marine Corps Base
Camp Pendleton, California

II. SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

FINDINGS

1. The Santa Margarita River Basin drains approximately 740 square miles of watershed in San Diego County and Riverside County, California. Mean annual runoff to the Pacific Ocean has been about 20,000 acre-feet.

2. The 1965 population of the study area is approximately 50,000 inhabitants, concentrated mainly in the vicinity of Fallbrook and within Camp Pendleton, a U. S. Marine Corps facility.

3. The economy is primarily agricultural, with strong support from the military activities at Camp Pendleton.

4. Municipal and agricultural water is derived from the surface and ground water of the basin. These sources are supplemented by imported water from the San Diego Aqueduct. Total annual water use in the study area in 1965 was about 20,000 acre-feet.

5. The estimated average annual extraction from ground water in Camp Pendleton is about 6,500 acre-feet. This extraction is made possible by the extensive ground water recharge program carried on by the base.

6. Santa Margarita River water is of good quality though moderately high in total dissolved solids and hardness, but acceptable for all municipal, industrial, and agricultural uses.

7. Municipal waste treatment plant effluents are discharged to the Santa Margarita River or tributaries for natural or controlled ground water recharge. In sparsely settled areas, waste from individual domestic units is disposed of by subsurface percolation. Pollution problems at the present level of development are minimal, although local problems have been reported.

CONCLUSIONS

1. The study area population is projected to increase from about 50,000 persons (1965) to about 420,000 by the year 2020. Most of the projected growth will occur in the Upper Basin.

2. Annual municipal and agricultural water requirements for the entire study area will increase from about 20,000 acre-feet (1965) to about 182,000 acre-feet by the year 2020. Since full development of the local water resources will not meet water requirements, continued reliance must be placed on imported water.

3. Beneficial uses of flowing waters of the Santa Margarita River below De Luz Dam other than for ground water recharge, are and will continue in the future to be negligible. Therefore, it will not be necessary to provide separable storage in the proposed project reservoirs for the purpose of regulating stream flow for water quality control.

4. The proposed project will result in an increase in total dissolved solids in the impounded waters due to increased water losses by evaporation. However, a greater quantity of water will be available for ground water recharge, and the overall effect on ground water quality in the recharge area will, therefore, be negligible.

5. The projected population for the Upper Basin will result in sharply increasing waste loads. If these waste loads are discharged directly or indirectly to the streams they will adversely affect the quality of the waters in the proposed reservoirs. Eutrophic conditions induced by nutrients will cause water quality problems in impounded water, adversely affecting the water supply and recreational use of the reservoirs unless appropriate water quality management plans are developed and implemented.

6. The most feasible plan to prevent the predicted eutrophic conditions in project reservoirs appears to be to transport treated M&I waste from upstream areas to areas below the proposed reservoirs where a limited quantity may be used for controlled recharge of ground waters and possibly land irrigation. The balance of the waste water surplus to these needs could be exported for disposal in marine waters.

7. The control of nutrient loads into the proposed reservoirs will require adoption and implementation of a comprehensive water quality management plan.

RECOMMENDATIONS

It is recommended that:

1. The State Water Resources Control Board through the San Diego Regional Water Quality Control Board take a leading role in stimulating the development and implementation of a coordinated water quality management plan for the Santa Margarita River Basin.

2. The Federal Water Pollution Control Administration assist in this effort by providing technical and grant assistance in development and implementation of the basin plan.

3. The Bureau of Reclamation and the U. S. Navy, as major interested agencies in the basin, cooperate in the development of such plans. In the detailed planning of the Santa Margarita project, consideration should be given to opportunities for implementation of pertinent features of the water quality management plan finally adopted for the basin.

III. PROJECT DESCRIPTION

The Santa Margarita Project as proposed by the Bureau of Reclamation will consist of a two-dam plan; the 115,900 acre-foot De Luz Reservoir and the 36,500 acre-foot Fallbrook Reservoir. These two features will provide irrigation, municipal and industrial water supplies, flood control protection, recreational development, and fish and wildlife mitigation and enhancement. De Luz Dam (see Figure 1) will be a homogenous earth-fill dam located on the Santa Margarita, rising about 200 feet above the stream bed. Fallbrook Dam will be an earth-fill structure about 190 feet high.

Pursuant to court judgments, water produced by the project will be divided between Camp Pendleton (U. S. Marine Corps) and the Fallbrook Public Utility District in accordance with the memorandum of understanding and agreement negotiated by the two agencies on June 27, 1968. Water for the Fallbrook Public Utility District will be diverted into its distribution system at the Fallbrook Dam. Water for Camp Pendleton will be released into the river channel below De Luz Dam to recharge the ground water basin where wells located within the base will extract this water for use within the military reservation.

In addition to the present surface water yield of the basin (4,000 acre-feet per year), the two reservoirs will yield an additional 11,000 to 12,000 acre-feet of water annually. This supply will be supplemented by ground water extractions and water purchased from the San Diego County Water Authority, the major supplier of imported water in the study area. Regulatory storage will be provided by the project reservoirs so that water imported from the Colorado River and the California State Water Project can be taken at a uniform delivery rate, thereby permitting lower water costs to most service areas.

IV. STUDY AREA DESCRIPTION

LOCATION

The Santa Margarita River drains about 740 square miles of Pacific coastal mountains and discharges into the Pacific Ocean north of Oceanside, California. The entire basin is divided geographically by the coastal mountains into two sectors; an upper basin and a lower, or coastal, basin (see Figure 1), both lying within San Diego County and Riverside County.

The Upper Basin is drained by Murrieta, Warm Springs, Temecula, Tucalota, and Santa Gertrudis Creeks. These tributaries merge near the town of Temecula to form the Santa Margarita River. From this confluence, the main river flows through Temecula Canyon, a narrow, precipitous gorge that cuts about five miles through the coastal mountains and then drains the lower coastal portion of the basin to the Pacific Ocean. The Upper Basin drains about 600 square miles of watershed located in the coastal ranges separating the coastal plains from the inland Colorado River deserts. Peaks in the upper watershed rise to an elevation of 6,800 feet. Below the mountains the Upper Basin is primarily gently rolling grassland, which is presently being dry-farmed.

The steep and rocky peaks of the coastal ranges do not exceed 2,500 feet in elevation. Downstream, the canyon widens but remains relatively steep and narrow until it reaches the confluence of De Luz Creek. Below De Luz Creek, the river flows through the alluvial valley of the coastal plain. The coastal portion of the basin is composed of 150 square miles of watershed of which 60 square miles is located within Camp Pendleton, a U. S. Marine Corps installation.

CLIMATE

The climate of the Santa Margarita Basin is typically Mediterranean, which is characteristic of all southern California. In the coastal plain, summer temperatures are moderate. Light frosts occur only occasionally during the winter, although the Upper Basin has a wider range of temperature because of the higher altitudes there. Considerably more frost and higher summer temperatures are experienced inland. Rainfall varies from about 10 inches annually in the lower areas to about 30 inches annually in the higher mountain peaks. About 90 percent of the precipitation occurs during the months of November through April and the remainder of the year is hot and dry. Snowfalls occasionally occur at the higher elevations but do not persist for any length of time.

V. WATER RESOURCES OF THE STUDY AREA

SURFACE WATER

Because the study area is semi-arid, stream runoff is largely the result of seasonal rainfall on the watershed. During the dry summer months, flows in the river decrease to a few cubic feet per second and frequently reach no-flow conditions in the Lower Basin, although perennial flows are recorded in Temecula Canyon. The historical record of flows (1923-1965) at the Ysidora gaging station near the mouth of the river shows that no-flow conditions existed during more than 40 percent of that period. Review of the historical record shows that the annual runoff of the Santa Margarita River to the ocean varies widely from season to season. The mean annual runoff at the Ysidora gaging station is about 20,000 acre-feet [1] but the median flow is only 5,400 acre-feet. During the flood of February 1927, a peak of 33,000 cfs was recorded.

Records of surface water analysis at the Fallbrook gaging station, as reported by the California Department of Water Resources [2], indicate the water is of the bicarbonate type and moderate to very hard with moderately high total dissolved solids. A summary of selected water quality indicators at Fallbrook during the period 1951-1965 is shown in Table 1. The minimum and maximum range reflects the variable runoff and the low dry season flows. However, chemical constituents under most conditions are within the mandatory limits prescribed by the U. S. Public Health Service Drinking Water Standards [3] and the Interim Policy on Mineral Quality of Drinking Water adopted by the California State Board of Public Health in September 1959 [4]. The water is considered useable for all purposes.

GROUND WATER

The ground water in the coastal plain has been used extensively. During the 10-year period, 1955-1964, the annual water use by Camp Pendleton from the ground water basin of the Santa Margarita River was about 6,500 acre-feet [5]. This relatively large extraction from the lower basin in relation to basin runoff is made possible by the extensive ground water recharge program carried out at Camp Pendleton. Spreading grounds created by off-channel and on-channel spreading basins located on the river bed increase stream bed infiltration. To further supplement the water resources, sewage effluent is returned to the river as a reclamation measure, thereby permitting greater ground water recharge and extraction. To obtain the greatest possible basin water yield, the recharge program is accompanied by a vigorous phreatophyte control program in the river and in Lake O'Neill. This water management system, a vital adjunct to the water resources of Camp Pendleton, has been in effect over 10 years.

TABLE 1

SURFACE WATER QUALITY [a/]
SANTA MARGARITA RIVER BASIN

CONSTITUENTS [b/]	MAXIMUM OF RECORD	MINIMUM OF RECORD
Calcium	113.0	54.0
Magnesium	39.0	5.0
Sodium	224.0	23.0
Potassium	5.5	2.6
Carbonate (CO_3)	34.0	0.0
Bicarbonate (HCO_3)	495.0	116.0
Sulfate	171.0	84.0
Chloride	468.0	97.0
Nitrate	15.0	0.0
Fluoride	0.78	0.00
Boron	0.57	0.08
Silica (SiO_2)	40.0	25.0
Total Dissolved Solids	977.0	520.0
Total Hardness (as $CaCO_2$)	447.0	142.0
Specific Conductance (Micromhos at 25°C.)	1592.0	561.0
pH	9.4	7.1
Temperature (°F)	87	46
Dissolved Oxygen	19.0	4.8
Percent Saturation	231	55
Turbidity (parts per million)	700.0	2.0
Coliform (MPN per ml)	24,000	0.45

a/ Data from California Department of Water Resources [2].
Period of Record, February 1951 to December 1965.
Santa Margarita River near Fallbrook, California.

b/ Concentrations expressed in milligram per liter, unless noted otherwise.

In the alluvium of the coastal plain, the ground water reflects the quality of the basin runoff. However, recharging of ground water with sewage effluent by Camp Pendleton has resulted in slightly higher mineralization, notably in the wells located at the extreme western end of the basin, near the Pacific Ocean. In the Upper Basin, the ground water resource is less developed in the past, since demands are lower than the coastal basin. Small wells are located throughout the basin for domestic and stock-watering purposes but more recently, with the active commercial-residential developments in the Upper Basin, interest has turned to greater use of the gound water resources. Wells up to 1,000 gpm have been developed and higher extraction of ground water is scheduled to meet the growing demands within the Upper Basin. These recently developed wells reach deeper aquifers containing water of higher salt concentration. The large scale development of these deeper aquifers will have a direct impact on the quality of surface waters and where recharge is practiced, will also affect the ground water of the Upper Basin.

Records of ground water analysis in the Upper Basin, as reported by the California Department of Water Resources [6], indicate the water is of the bicarbonate type, generally hard, and with moderately high dissolved solids. Typical analysis of waters in the Upper and Lower Basins are shown in Table 2. Some wells contain highly mineralized water but these wells are exceptional and not typical of the area.

TABLE 2

GROUND WATER QUALITY
SANTA MARGARITA RIVER BASIN

CONSTITUENTS [c]	LOWER BASIN [a] WELL 10S/4W-5D1	UPPER BASIN [b] WELL 7S/3W-17P2
Calcium	56.0	80.0
Magnesium	19.7	28.0
Sodium	92.0	84.0
Potassium	2.6	1.0
Carbonate (CO_3)	--	--
Bicarbonate (HCO_3)	224.0	299.0
Sulfate	92.0	40.0
Chloride	100.0	137.0
Nitrate	0.0	12.0
Fluoride	0.58	0.10
Boron	0.10	0.05
Silica (SiO_2)	26.0	--
Total Dissolved Solids	544.0	558.0
Total Hardness (as $CaCO_3$)	212.0	315.0
Specific Conductance (Micromhos at 25°C)	--	950.0
pH	8.0	8.0

a/ Office of Ground Water Resources, Office Records 1967,

b/ Department of Water Resources, Bulletin No. 130-65 [6].

c/ Concentration expressed in milligram per liter, unless noted otherwise.

VI. ECONOMY

PAST AND PRESENT

The early history of the Lower Basin was associated with the settlement founded in 1769 by the Spanish Government. The land was part of the San Luis Rey Mission and was mainly devoted to orchards, crops, and cattle ranching. After the annexation of California by the United States in 1850, the new owners and their descendents operated the land as a farming and ranching enterprise until 1942, when part of the rancho was sold to the United States for use as a Marine Corps training base. Presently, about 135,000 acres of the coastal plain are occupied by the U. S. Navy at Camp Pendleton (U. S. Marine Corps), the Fallbrook Naval Weapons Station and the U. S. Naval Hospital. For the purposes of this report, the name Camp Pendleton refers to the entire military complex within the study area.

Camp Pendleton is an important part of the economy of the project area. Although the level of activities fluctuates, depending on the training requirements, its population has averaged about 35,000 in recent years. Other communities in the Lower Basin are Fallbrook (1965 population 5,000) and De Luz (1965 population 200).

The economy of the Lower Basin is primarily based on agricultural and military activities, augmented by tourism. The climate and the terrain are suitable for growing high-value semi-tropical fruits, citrus fruits, and avocado. Although Camp Pendleton is a military facility, a small part of the land within the base is leased for cultivation of citrus fruits, vegetables, and commercial flowers.

In early California history, the San Luis Rey Mission, located near Oceanside, used the Upper Basin mainly as grazing land for mission cattle. When California became a state, the area started to be divided into small ranches and farms. Today the area is used chiefly for cattle and sheep ranching but this is changing fast. The main communities in the sparsely settled area are Murrieta (1965 population 500) and Temecula (1965 population 500).

FUTURE

As the suburbs of metropolitan Los Angeles expand southward and San Diego expands northward, the study area, now sparsely settled, will merge into these two growth centers. Agriculture will continue to be an important segment of the economy mainly because of demands for the high-value specialty crops that can be grown in this Mediterranean type climate, but rapid commercial-residential development of the area will become its most dominant factor. Corresponding incremental population growths have been projected for this study.

For evaluation of future waste loads of the Basin, population projections for the study area furnished by the Bureau of Reclamation are shown in Table 3. The Lower Basin is composed of three basic population units: Camp Pendleton; the service area of the Fallbrook Public Utility District; and the service area of the De Luz Heights Municipal Water District. These are the principal units discharging wastes to the Santa Margarita River below Temecula Canyon. The Upper Basin above Temecula Canyon is composed of a single population unit. Growths in this area will be centered around the development of the Rancho California Corporation and surrounding communities.

TABLE 3

POPULATION PROJECTIONS a/
SANTA MARGARITA RIVER BASIN

	1965	1970	2000	2020
Upper Basin (above Temecula Canyon)	2,000	6,500	181,000	350,000
Lower Basin				
Camp Pendleton b/	35,000	35,000	35,000	35,000
De Luz Heights Municipal Water District	100	250	1,000	2,000
Fallbrook Public Utility District	10,000	11,500	21,000	30,000
Total	47,100	53,250	238,000	417,000

a/ Source: Bureau of Reclamation [5, 6].

b/ Mobilization strength about 100,000.

VII. WATER REQUIREMENTS - MUNICIPAL, INDUSTRIAL, MILITARY, AND AGRICULTURAL

PAST AND PRESENT WATER USES

Present water usage in the study area is primarily municipal and agricultural. It is estimated that the present total of municipal and agricultural demands is about 20,000 acre-feet per year [5]. Demands in the Lower Basin are associated for the most part with Camp Pendleton and the Fallbrook Public Utility District. Annual municipal demand, estimated at 122 gallons per capita per day, is about 8,000 acre-feet [5]. Most agricultural demands in the Lower Basin occur in the service area of the Fallbrook Public Utility District. Obviously, the existing water resources of the basin are not adequate to meet these demands, but supplemental water is available from the San Diego Aqueduct of the San Diego County Water Authority. In fact, the Fallbrook Public Utility District at present derives all their supply from this source.

In the Upper Basin, the water demands of the area are mainly for domestic and agricultural uses. Vail Dam (see Figure 1) was completed in 1949 primarily for the agriculture on the Vail Ranch but in 19 years of operation the 50,000 acre-feet reservoir has never been filled. The municipal and agricultural requirement of the upper area is estimated to be more than 4,500 acre-feet annually.

FUTURE WATER USES

Projections of future municipal, industrial, and agricultural water uses for the Lower Basin have been made by the Bureau of Reclamation [5], and these are summarized in Table 4. Municipal and industrial water demand is projected to increase from 0.150 acre-feet per capita per year (134 gpd) in 1970 to 0.176 acre-feet (150 gpd) by 2020 for the Fallbrook service area. According to base officials, the Camp Pendleton water consumption rate will rise to about 200 gallons per capita-day.

TABLE 4

M&I, MILITARY, AND
AGRICULTURAL WATER REQUIREMENTS
SANTA MARGARITA RIVER BASIN
(AF/Yr)

	1970	2000	2020
Upper Basin			
M&I	975	30,770	61,600
Agriculture	29,120	89,700	88,400
Lower Basin			
M&I a/ b/			
Camp Pendleton	8,500	8,500	8,500
De Luz Heights MWD	35	170	350
Fallbrook PUD a/	1,720	3,570	5,280
Agriculture	12,110	15,280	17,480
Total	52,460	147,990	181,610

a/ Parts of service area are outside of drainage basin.

b/ Under mobilization, demand could increase to 24,000 AF/Year.

In the Upper Basin, water will be used mainly for municipal, industrial, and agricultural purposes. Based on the projected commercial-residential-industrial developments and agricultural needs, the total water requirement of the entire basin is expected to increase from a demand of about 52,000 acre-feet in 1970 to a demand of 182,000 acre-feet in 2020.

The projected large demands of the basin show that the total yield of the proposed reservoirs will be able to meet only a portion of the future water demand of the study area. Imported water has always been an essential supplement to the supply of the southern California coastal plain. The San Diego Aqueduct crosses the Upper Basin, bringing imported water from the Colorado River and, in the near future, water from the California Aqueduct of the State Water Project. Water from these facilities will meet water requirements in the southern California coastal plain, at least until 1990. Other means of providing more water for the southern part of the state after 1990 are being studied. The possible future sources include increased imports from northern California and desalination of sea water.

VIII. WATER QUALITY CONTROL

PRESENT SOURCES OF POLLUTION AND WASTE WATER

The pollution of surface water in the Santa Margarita River Basin is minimal at present. In the Upper Basin, the small towns and isolated farm houses dispose of domestic waste through community or individual septic tanks. Fallbrook disposes secondary effluent to Fallbrook Creek, a tributary of the Santa Margarita River. During extremely dry years with low runoff, algal blooms have been reported in Lake O'Neill. Algal blooms have been reported also at the lagoon at the mouth of the Santa Margarita River. These algal blooms have been attributed to sewage borne nutrients.

The sewage treatment facilities at Camp Pendleton are composed of more than nine plants. About six of these dispose of effluent into percolation beds located on the Santa Margarita River and the remainder are located outside the study area. The recharge beds on the Santa Margarita River are operated primarily to gain the greatest possible yield from the ground water basin. A summary of the major waste sources under the present stage of development is shown on Table 5.

TABLE 5

PRESENT WASTE WATER SOURCES
SANTA MARGARITA RIVER BASIN

COMMUNITY	POPULATION (1965)	TREATMENT	EFFLUENT DISCHARGE
Murrieta	500	Septic Tanks	Percolation
Temecula	500	Septic Tanks	Percolation
Radec	50	Septic Tanks	Percolation
Sage	50	Septic Tanks	Percolation
De Luz	200	Septic Tanks	Percolation
Fallbrook a/	5,000	Secondary/Lagoons	Land and Fallbrook Creek
Camp Pendleton	35,000 total		
Plant No. 1	-	Secondary/Lagoons	Lake O'Neill
Plant No. 2	-	Secondary/Lagoons	S. M. River
Plant No. 3	-	Secondary/Lagoons	S. M. River
Plant No. 8	-	Sed./ Lagoons	S. M. River
Plant No. 13	-	Sed./Lagoons	S. M. River
Fallbrook Ammunition Depot	-	Sedimentation	Fallbrook Creek

a/ Fallbrook Sanitary District

FUTURE SOURCES OF POLLUTION AND WASTE WATER

1. Municipal and Industrial

In contrast to the present agricultural economy, the future growth and development of areas in both Upper and Lower Basins are expected to be primarily residential-commercial-industrial. However, the character of the area in Camp Pendleton is expected to remain oriented essentially to the military, with minor changes in land use. The sewage treatment plants in the military reservation will continue to discharge into the Santa Margarita River, under the ground water recharge program. The quantity of waste is expected to be unchanged but under mobilization, the waste discharge might increase to as much as 15 mgd.

In the non-military part of the river basin, rapid growth is expected to center around the service areas of the Fallbrook Public Utility District, the De Luz Heights MWD and the Upper Basin above Temecula Canyon. In the Upper Basin alone, the population is expected to reach 350,000 residents [7]. The projected sewage discharge associated with the sub-areas of the basin are shown in Table 6. In the Upper Basin, it can be expected that since the residential-commercial-industrial developments will be grouped into medium-size cities, wastes will be given secondary treatment and the effluent will be discharged to percolation ponds. However, as the Upper Basin attains expected population growth (350,000), effluent will reach surface waters of the Santa Margarita River.

TABLE 6

M&I WASTE LOAD
SANTA MARGARITA RIVER BASIN
(mgd)

	1970	2000	2020
Upper Basin	0.60	19.20	38.50
Lower Basin a/			
Camp Pendleton b/	3.50	3.50	3.50
De Luz Heights	0.02	0.15	0.20
Fallbrook S.D. c/	1.30	2.80	3.70
Total	5.42	25.65	45.90

a/ Parts of service areas of Camp Pendleton and the Fallbrook Sanitary District discharge waste outside of the basin.
b/ Under mobilization, flow could increase to 15 mgd.
c/ The Fallbrook Sanitary District which is located within service area of the Fallbrook Public Utility District discharges effluent to Fallbrook Creek.

2. Project Construction Effects

During the construction of the project, adequate measures must be taken to protect both surface and ground waters. Provisions should be included in contract specifications to make contractors cognizant of the need to protect water quality in the work area. Silt detection basins should be constructed at all work areas to eliminate excessively turbid water leaching from earth work. In equipment maintenance areas, special precautions should be taken to contain spilled fuel, lubrication products, and wash water. Sewage from construction camps should be contained on land. All construction activities that could affect water quality control should comply with requirements of local and state water quality control authorities. In compliance with Executive Order 11288, comments from the Federal Water Pollution Control Administration should be requested by the construction agency during the preparation of project plans and specifications.

WATER QUALITY OBJECTIVES

The primary purpose for maintenance of the quality of the Santa Margarita River and impounded waters is for the preservation of basin water for irrigation, municipal and industrial water supply, fish and wildlife maintenance, recreational enhancements, and the aesthetic values of the aquatic and natural environment of the reservoirs. The San Diego Regional Water Quality Control Board (RWQCB) has the responsibility authorized under State statutes to establish water quality control policies and protect the beneficial uses of these waters. Although policies have not been established for the Santa Margarita, the RWQCB has initiated studies leading to the setting of a water quality policy in 1969. The general policy of the Regional WQCB is to prohibit direct discharge of effluent to surface waters above impoundments and to promote land application and sub-surface percolation. The protection of impounded waters and careful consideration of salt balances in the entire basin would be important factors to be included in the Regional WQCB policy.

The San Diego Regional WQCB proposed in 1967 a water quality control policy for the lagoon located in tidal waters at the mouth of the Santa Margarita River [8]. This coastal lagoon has been designated as an area set aside for aesthetic enjoyment and for the propagation and sustenance of aquatic marine life, including waterfowl. Water quality objectives for the lagoon include a minimum dissolved oxygen level of 5.0 mg/l, pH to range between 7.0 and 8.6 and nutrient (nitrates and phosphate) levels which will not stimulate algae and emergent plant growths.

The U. S. Bureau of Sport Fisheries and Wildlife provided preliminary information for the Bureau of Reclamation [5] on the existing and future fisheries in the study area. Under a controlled program, the California Department of Fish and Game presently stocks trout and red eye bass on the middle reaches of the Santa Margarita River and have established a successful program. However, because these sections of the river will be inundated by Fallbrook Reservoir, this program will be curtailed, but a new program to establish a new fishery in the reservoir is under consideration by the Bureau of Sport Fisheries and Wildlife and the State Department of Fish and Game. Preliminary estimates show that Fallbrook Reservoir could provide an annual average of 174,000 angler-days of use and De Luz Reservoir, 22,000 angler-days.

Since the two project reservoirs will provide almost complete development of the basin runoff, no provision will be made to provide for releases below the De Luz Dam, except under the ground water recharge program administered by Camp Pendleton and reservoir spills. The lower reaches of the river at present are dry during a large part of the summer, except for water released under the recharging operation. Under these conditions, opportunities do not exist for developing a viable fishery in the surface water below De Luz Reservoir.

Heavy demands for recreation opportunities can be expected for the project reservoirs. The Bureau of Outdoor Recreation has predicted [5, 9] that swimming and boating will have attracted more than 345,000 persons annually by the year 1990 or 2000. The area of public use will be confined mainly to Fallbrook Reservoir because military restrictions at De Luz Reservoir will limit full public use of it. The military, however, will plan for controlled recreation use of the reservoir for military and related personnel and will cooperate in the operation of Fallbrook Reservoir to permit maximum recreation uses there.

Above Fallbrook Reservoir in the Upper Basin, the Santa Margarita River and tributary creeks are also dry during most of the summer months although reaches of the river in Temecula Canyon have perennial flows. As the area develops, return irrigation and M&I waste water will keep the river bed wet but these return flows will not be sufficiently dependable during the dry summer months for maintaining a fishery. Therefore, plans have not been proposed to develop a fishery in the streams above Fallbrook Reservoir although a small resident fishery may develop naturally in Temecula Canyon, where perennial flows are recorded.

WATER QUALITY CONTROL FLOW REGULATION NEEDS

The De Luz and Fallbrook Project will provide nearly complete development of the surface runoff of the Santa Margarita River. Except for uncontrolled reservoir spills, releases will be made from De Luz Dam only in accordance with schedules for the recharge of the ground water basin by Camp Pendleton. Incidental benefits to water quality may accrue as a result of these releases to surface waters during recharging operations but these have not been evaluated. Fishery and recreational uses are not planned for the area downstream of De Luz Reservoir. Only slight potential for fishery exists because of river hydrology and extensive ground water recharge operations under the proposed project operation. Therefore, the future fishery potential below De Luz Reservoir would be negligible. Since the coastal lagoon is under tidal influence, beneficial uses are possible without releases into the Santa Margarita from De Luz. Therefore, use of additional storage in either reservoir for the purpose of flow regulation for quality control in the Santa Margarita River below De Luz Dam would not contribute to the multiple purpose development of the water resources of the basin.

IX. OTHER EFFECTS OF PROJECT ON WATER QUALITY

EFFECTS OF UPSTREAM DEVELOPMENTS ON IMPOUNDED WATER

Predicted Water Quality

The future developments in the Upper Basin will be an important factor influencing the water quality of impounded water since the total runoff and waste load from this area will be discharged through Temecula Canyon and into Fallbrook Reservoir. Since De Luz Reservoir will be filled by releases from the upper impoundment, its water quality too will be influenced by water in Fallbrook Reservoir and, therefore, by developments in the Upper Basin. Estimates of total dissolved solids, nitrogen, and phosphorus loads from the Upper Basin are shown on Table 7. The salt loads reflect local runoff, M&I waste, and agricultural surface and subsurface return water. A significant factor included in the evaluation of these loads is the quality of imported water, which is the major source of water of the Upper Basin. Imported water at present is derived from the San Diego Aqueduct, with the primary source located on the Colorado River. In the future, better quality water from the California Aqueduct from northern California will supplement the present sources and this factor has been included in the evaluations.

A review of Table 7 shows during the early period of the project, the major salt loads from the Upper Basin will be derived from the natural runoff and agricultural return water. However, by the year 2000, the predicted population increase will make M&I wastes the major source of salt loads. It should be noted that even at the 2020 level of development, natural runoff and agricultural waste from the Upper Basin will still contribute a significant TDS load to Fallbrook Reservoir, although the nutrient load will form a smaller proportion of the total.

TABLE 7

SALT LOAD FROM UPPER BASIN
SANTA MARGARITA RIVER
(Tons/Year)

SOURCE	1970	2000	2020
M&I Waste [a]			
Total Dissolved Solids	880	27,816	55,687
Nitrogen (as N)	18	585	1,172
Phosphorus (as P)	5	161	322
Natural Runoff and Irrigation Return Flows			
Total Dissolved Solids	17,475	45,700	45,100
Nitrogen (as N)	45	115	114
Phosphorus (as P)	4	9	9

[a] Based on 50% removal of nitrogen and 30% removal of phosphorus in secondary treatment process.

To provide information on the future quality of impounded water, data on the waste loads from the Upper Basin were merged with data on the hydrologic operation of Fallbrook Reservoir. The 40 years of hydrologic record, 1925-1964, were applied to an operation study furnished by the Bureau of Reclamation to predict water quality at Fallbrook. Salt loads from the Upper Basin were based on a single cycle use for M&I and agricultural demands since reuse of M&I and agricultural returns was not considered in the evaluation. The combined effects of waste loads, reservoir evaporation, and storage of imported water on TDS, nitrogen, and phosphorus concentrations were included in this evaluation. Results are presented in Table 8 in which concentrations of the three water quality parameters are shown at the 2020 level of development. The mean TDS was about 900 mg/l over the 40-year operation, with peak values reaching 1150 mg/l; the mean nitrogen was about 10 mg/l, and reached a peak of 12 mg/l; the mean phosphorus of about 2.5 mg/l rose to peaks of about 3.0 mg/l. This evaluation assumed complete mixing of the waste with reservoir water and did not consider nutrient trapping or recycling. Further, it was assumed that waste entering Fallbrook Reservoir would be released immediately after mixing to maintain reservoir level in accordance with the Bureau of Reclamation's operation schedules.

Since the inflow to De Luz Reservoir include not only imported water stored there for Camp Pendleton, and local runoff but also Fallbrook releases, it can be predicted that the mineral concentrations of De Luz water will be affected directly by the predicted quality for Fallbrook Reservoir. The salt concentration in De Luz on the average will be increased above that normally expected due to the evaporative effects of impoundment and the relatively small waste loads from the De Luz area population. The ground water available to Camp Pendleton will reflect greater salt concentrations than that contained in De Luz Reservoir due to salt pickup in the ground water recharge operation.

The predicted TDS level in Fallbrook Reservoir will greatly exceed the level recommended by the U.S.P.H.S. Drinking Water Standards (500 mg/l). Nevertheless, the water is still regarded as usable in the absence of better quality water as attested by various communities in California and other states which use water with equal if not higher solids concentrations than that predicted for Fallbrook Reservoir.

TABLE 8

QUALITY OF IMPOUNDED WATER
(milligrams per liter)

	FALLBROOK RESERVOIR a/	SANTEE WATER RECLAMATION PROJECT (1965) b/	CACHUMA RESERVOIR (1960) c/
Total Dissolved Solids	900.00	1,100.00	602.00
Total Nitrogen (as N)	10.00	2.93	9.33
Total Phosphorus (as P)	2.50	0.58	1.00
Algal Bio-mass	50-125.00 d/	20.00	50.00 d/ e/

a/ Mean values for year 2020 level of development.
b/ Mean values of Pond No. 4 in 1965 [10].
c/ Mean values in 1960 [11].
d/ Projected bio-mass (mg/l) in euphotic zone based on algal growth potential (AGP) values.
e/ Plankton population of 402,500 SAU (Standard area units) has been recorded [11].

The California Department of Public Health [4] permits the use of water with total solids up to 1,000 mg/l where no other suitable water is available. Levels up to 1,500 mg/l are permitted as a temporary supply. Some improvement in predicted TDS levels can be expected, if imported water containing a greater proportion of better quality California Aqueduct water from northern California will be available locally. For the evaluation, a TDS of 500 mg/l [5] in imported water was assumed, reflecting a mixture in equal parts of Colorado River water and California Aqueduct water.

It is also noted that the predicted mean nitrogen level (as N) of about 10 mg/l equals the U. S. Public Health Service recommended limiting concentrations for nitrate nitrogen. If all of the nitrogen present were to exist in this single form, it would be unacceptable as a source of drinking water. While this condition would not likely be encountered in the reservoirs, it is probable the ground recharge of these waters would convert most of the nitrogen to the nitrate form. Although biological denitrification could reduce the total nitrogen content in the ground water, the prospect of high nitrates in drinking water should not be discounted.

Detriments

The significance of nitrogen and phosphorus in impounded waters is related to the stimulation of excessive growths of algae and other aquatic plants. Critical conditions in reservoirs are created by algal blooms that result in massive growths of bio-mass, discoloration of water, and wide fluctuation in dissolved oxygen and pH levels. The respiratory requirements of algae

can represent a significant oxygen demand and when these planktonic life forms die, their decay further depresses oxygen levels. Subsequently, they create odoiferous and unsightly floating scums when they are buoyed up to water surface by gaseous products of decay. This deterioration of water quality can result in fish-kills, cause unpleasant tastes and odors in municipal water supplies, and spoil the aesthetic environment of an aquatic recreation area.

To determine the relationship between these detriments, the nutrient levels of impounded waters at Cachuma Reservoir in Santa Barbara County and the Santee Recreation Project in San Diego County, may be compared, as shown in Table 8.

From the time of initial filling, Cachuma Reservoir has had a history of water quality problems caused by extensive algal blooms. The impact of taste and odor problems on the local public water supply systems has been severe and is at present under continuing evaluation to still public complaints.

The Santee Recreation Project is a facility that utilizes sewage effluent as the primary water source. The waste is given secondary treatment in an activated sludge process, and then further treated in an oxidation pond. Effluent is filtered through percolation beds located in drainage channels before collection and routing through four recreation ponds. For purposes of comparison, the nutrient level in the second pond, which is used extensively for aquatic recreation, is shown on Table 8. Although the facility has been operated over a five-year period and the recreation project has been termed a success, severe algal blooms resulting in fish-kills have been reported. Algal bio-mass of up to 20 mg/l has been recorded [10]. The presence of high concentrations of nutrients in these recreation lakes has been the primary cause of these blooms.

If conditions at these existing facilities, which are located in similar climatic areas, can be used as guides, it can be predicted that similar water quality problems associated with excessive enrichment of impounded water will also occur in impounded project water. Employing a relationship between algal growth potential (AGP) and nutrient levels [12], it can be predicted that an algal bio-mass having 100-250 mg/l could exist in Fallbrook Reservoir at the 2020 level of development. However, the reservoir will probably not achieve this full potential, because all nutrients will not be available in assimilative forms simultaneously. However, a maximum of 50 percent of this potential or 50 to 125 mg/l can reasonably be expected in the euphotic zone. Even at the lower level of 50 mg/l, the treatment and use of impounded waters for a public water supply would be severely limited and the recreational potential of the reservoir adversely affected. By comparison, this lower predicted level exceeds mean algal growths conditions in Santee Project Ponds and equals projected algal growths in Cachuma Reservoir (see Table 8).

When subject to excessive enrichment, reservoir water will require chemical treatment and filtration for M&I uses. Since Camp Pendleton water will be used primarily for recharge rather than for direct use from impoundment, reservoir algal problems will have less impact on their system. The California Department of Public Health has informed the Fallbrook Public Utility District that, when State Water Project water is received, all imported water will require full treatment. Although the District will deliver imported water through the distribution system, about 2000 acre-feet annually of imported water would be stored and withdrawn from Fallbrook Reservoir. For the purpose of this study, it is assumed that this imported water and the 5000 acre-feet of project water would require treatment before distribution by the District. However, since this reservoir water requires treatment to conform with the State Department of Public Health requirements, only the additional expense attributable to algal growths and taste and odors control would be considered a project impact. It is estimated that these reservoir induced problems would incur an annual cost of $35,000 attributable to additional chemical costs, taste and odor control needs, and excess sludge handling operation. Evaluated over a 100-year period, these reservoir induced costs have a present value (1970) of about $1,033,000.

The Bureau of Outdoor Recreation has made projections of the recreational potential in the two project reservoirs [9]. The Bureau predicts that as many as 345,000 recreational days per year will be reached within 20 years of project completion. Based on visitor-day values, benefits by that time will reach $414,000 per annum. These recreation uses include estimates by the Bureau of Sport Fisheries and Wildlife for the proposed fishery in the reservoirs, which predict that fishing demands will increase up to 174,000 angler-days per year 20 years after project completion.

It is conceivable that these recreational projections will be diminished up to one-half due to nutrient enrichment of impounded waters. By comparison, the effects of nutrient enrichment at Clear Lake, Lake County, California, have caused a 40 percent depletion of recreational potential, as reported in a 1967 survey [12]. It should be noted that the nutrient level in Clear Lake during this period was lower than the predicted level in the project reservoirs at the 2020 level of development. It is recognized, of course, that a direct comparison of detriments can not be made because other economical, environment and social factors will have bearing on the subject. But assuming a 50 percent reduction in recreation potential, the present worth (1970) of the recreational benefits will decrease by $5,650,000, or $190,000 per annum, as shown by a 100-year projected evaluation. Thus, when the cost of this recreational detriment is added to the water treatment cost, a total annual cost of about $225,000 will have been incurred by degraded water quality, due to nutrient enrichment of the impounded water.

PREVENTIVE MEASURES

It is obvious in view of the predicted quality of water in the project reservoirs that preventive measures should be considered. Alternative plans are discussed below.

Nutrient Export

A plan to export M&I wastes from the Upper Basin so as to bypass the project reservoirs was evaluated as a means to preclude eutrophication of impounded waters. Under this plan (see Figure 1) waste water will be collected at the head of Temecula Canyon by a central collection system serving the entire Upper Basin and conveyed by a master sewer to the Lower Basin.

Extensive recharge and irrigation operations with treated sewage are in effect in the Lower Basin and exported waste water could be utilized here to maximize water resources. Water surplus to these basin recharge and irrigation needs will be exported for disposal by a marine outfall into waters of the Pacific Ocean, since it is recognized that the Regional Water Quality Control Board prohibits the direct discharge of effluent to surface waters reaching coastal lagoons.

A scheme to collect the M&I waste from the Upper Basin should not present formidable technical problems. Since future commercial-residential-industrial developments will be centered in the Murrieta-Temecula area, a master sewer serving this area should be located so as to convey waste flows to the eastern end of Temecula Canyon. Here the wastes will be provided secondary treatment before export by gravity to the upper reaches of Fallbrook Reservoir. From this location, a lift station will pump sewage to the Fallbrook area, preferably along Rainbow Creek. The sewage will flow by gravity through Fallbrook, around Lake O'Neill to the Santa Margarita River. The sewage will continue by gravity in a sewer located along the river to an outfall discharging into the Pacific Ocean. A short ocean outfall is envisaged since sewage would have been provided secondary treatment. Sewage effluent needed for ground water recharge and agricultural irrigation could be diverted, as needed, from the last section of the export route.

Sewage might also be directed along a southerly route into the adjacent San Luis Rey River Basin (see Figure 1), where effluent could also be used for ground water recharge and irrigation. Sewage surplus to reclamation needs could be combined with treated sewage from the Oceanside area for disposal into a master marine outfall serving waste waters from both basins. This alternate scheme merits further study since the joint plan could result in construction economy and further, reclaimed water may be in greater demand in the San Luis Rey Basin. But this alternate export plan will require careful consideration in view of legal problems of water rights adjudicated between the two basins.

For the purpose of this study, a conveyance system including a marine outfall at the Santa Margarita River was used as a basis for preliminary cost analysis. Under this scheme, the total length of gravity sewer, force main and marine outfall will be about 28 miles. The export sewers will be sized at an early stage for a 40 mgd flow, the total waste flow expected at the 2020 level of development, since indications are that the Upper Basin will achieve rapid early growths in the near future. Consideration

was not given to the re-use of municipal and industrial waste in the Upper Basin, therefore, the total projected waste load was subjected to export. It is estimated that the total cost for the export scheme will have a present worth (1990), at the time of first need, of about $8,000,000. The annual cost for this capital investment will be about $143,000, a figure based on a 100-year evaluation period beginning at the first year of the reservoir project (1970) at 3 $\frac{1}{4}$ percent interest. This annual cost does not include the collection sewers and secondary treatment plants within the Upper Basin, because these are considered local community costs and are not part of the export scheme. Also this cost does not include sewer easements, which for the most part will be located on public thoroughfares and near streams.

To this amortized cost for capital investments must be added an annual maintenance, operation, and replacement cost of about $103,000. This annual cost includes power cost for two sewage lift stations. Thus, the total annual cost for the export scheme will be about $250,000. This cost could be reduced if consideration were given to the value of exported water used for recharge in the Lower Santa Margarita or the San Luis Rey Basins. It is to be noted that imported Colorado River water, purchased for agricultural use or for ground water recharge, is valued at about $25 per acre-foot and this cost is anticipated to increase in the near future.

Advanced Treatment of Wastes

Present secondary treatment processes of M&I waste can reduce nitrogen concentration by 50 percent and phosphorus concentration by 30 percent [13]. Recent developments have shown that as much as 80 percent of phosphorus can be removed by design and operational modifications of the activated sludge process [14, 15]. However, these improvements cannot be accepted for general application without further development. Removal of as much as 80 percent nitrogen and 90 percent phosphorus is possible with advanced treatment methods that have been proven in laboratory, on pilot scale, and in small scale plants [16, 17, 18]. Their application to large facilities awaits only the need for them.

For the Upper Basin, a central treatment facility placed at the head of Temecula Canyon would be the most economical location. This single installation could serve the major commercial-residential-industrial developments in the Temecula-Murrieta area. Nutrient stripped effluent from this central plant could be discharged into Temecula Canyon, contributing to the runoff into the project reservoirs. The estimated total cost for tertiary treatment for nutrient stripping ranges from $150-$200 per million gallon [16, 17, 18]. This cost is in addition to the cost of secondary treatment and does not include the master collection system for the Upper Basin. The upper limit of tertiary treatment cost ($200/mg) was applied in an analysis which included no discount for the value of reclaimed waste water. Study shows the present worth (1970) of tertiary treatment costs will be about $16,957,906 and when spread over an 100-year evaluation period is equivalent to an annual cost of $573,745 for stripping of nutrient from M&I water.

Dilution of Nutrient with Imported Water

An alternative plan involving dilution of waste water with imported water was not considered in detail but is only mentioned here. Under this plan, the nutrient load from the Upper Basin would be diluted by imported water. However, this method would be expensive. Present cost for San Diego Aqueduct water used for municipal purposes is about $50 acre-foot [5] in the study area although agricultural water is available for $25 acre-foot. Although the need for imported water within the basin indirectly contributes to the improvement of the salt problem, because the quality of imported water is superior to local water quality, the use of this water solely for dilution purposes is not considered desirable or economical in a water deficit area.

BASIN WATER QUALITY MANAGEMENT

Even with plans to deter eutrophication of impounded water by export of M&I wastes, a comprehensive water quality management program is needed to permit maximum utilization of the limited water resources of the basin, since the export or tertiary treatment of the M&I waste from the Upper Basin is not by itself a guarantee of the preservation of the water quality of the basin. Reservoir operation analysis shows that even if all the M&I wastes from the Upper Basin were to be exported, the TDS in Fallbrook Reservoir would rise to about 730 mg/l mainly due to agricultural return water and reservoir evaporation. The same operation analysis shows that the nitrogen concentration would be about 1.4 mg/l (as N) and phosphorus levels would be about 0.05 mg/l (as P). The nitrogen levels could induce algal blooms under appropriate conditions. Attempts to re-use agricultural waste water in the Upper Basin will have a significant impact on the quality of water reaching the Lower Basin since the TDS and nutrient loads could increase by re-use of the relatively large volume of agricultural return water. Operation analysis shows that if the agricultural return water were to reach TDS concentrations of 1500 mg/l through re-use in the Upper Basin, the water quality in the Lower Basin would be seriously affected. Since present technology for treatment of agricultural waste for salt removal does not present any economical solutions at this time, water users of the Lower Basin might be seriously affected. Re-use of large quantities of M&I waste in the Upper Basin would incur adverse salt balance problems in the Upper and the Lower Basins. A comprehensive water quality management plan agreeable to users in both basins is essential to the maximum utilization of the proposed project itself.

In the Lower Basin below De Luz Reservoir, the management is largely under the jurisdiction of the U. S. Navy and the problems are amenable to direct control by a single agency. Even here, the operating agency must recognize the need to maintain a favorable salt balance in the ground water system. High mineral content of water from wells in the extreme lower end of the basin is evidence that a salt balance plan is needed to prevent deterioration of water quality. It should be noted that in the adjoining San Luis Rey Valley, the San Diego Regional Water Quality Control Board has imposed a TDS limit of 1500 mg/l on water used for recharge of the ground water basin. With the larger volume of imported water to be sent to the Santa Margarita basin in the future, a greater volume of return water will be available for salt balance needs in the Lower Basin ground water by maintenance of salt wastage to the sea by surface or subsurface flow to the Santa Margarita lagoon.

Early studies have been initiated by the San Diego Regional Water Quality Control Board to provide data and information in formulating a comprehensive water quality control policy for the Santa Margarita Basin. Public hearings are scheduled for 1969 as a prelude to the adoption of a policy to protect the water resources of the basin. The interests and cooperation of all water users within the basin will be necessary to implement a basin management program for water quality control and this program should be encouraged and guided by the Regional Water Quality Control Board.

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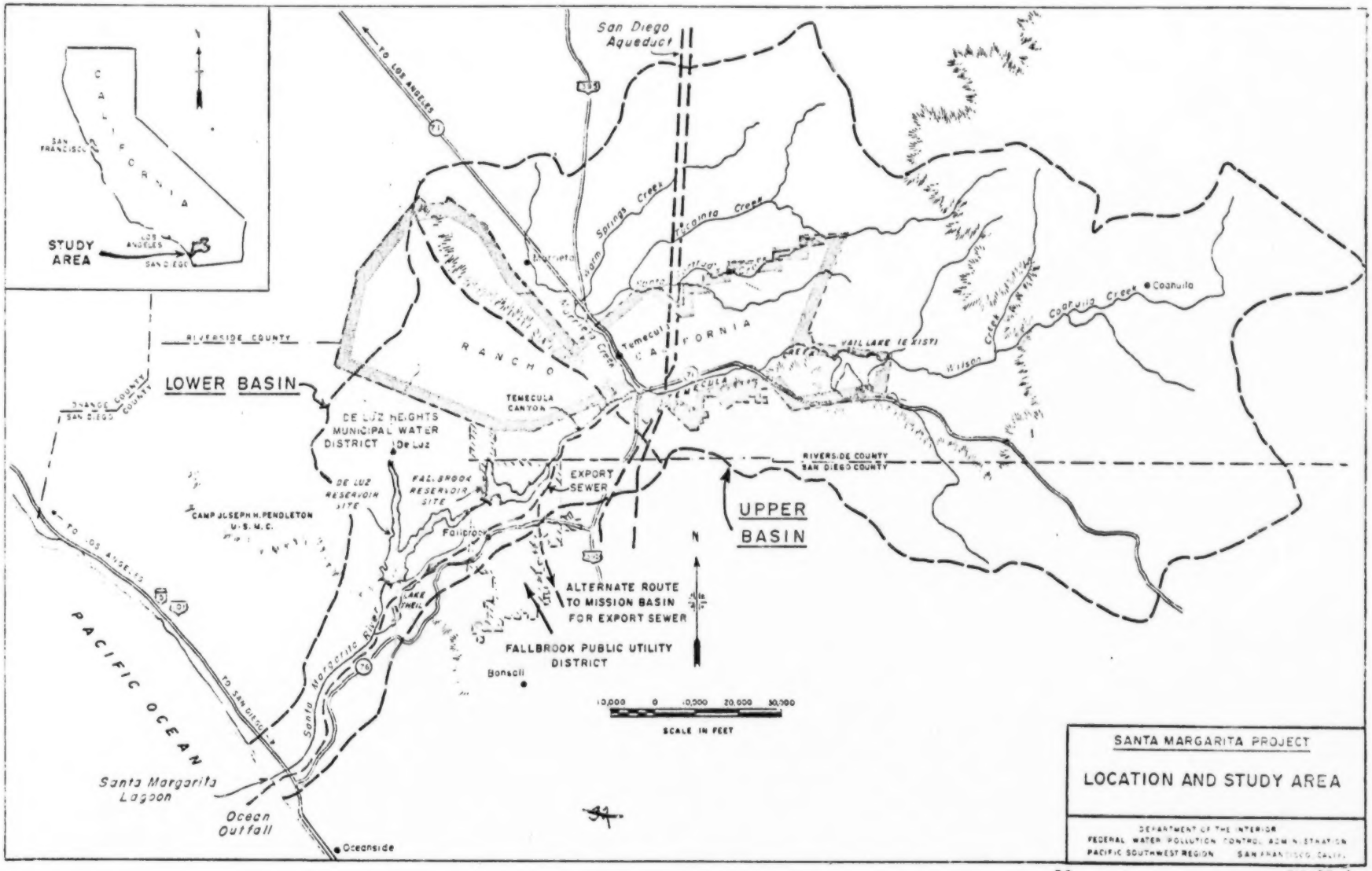
STUDY AREA
SAN FRANCISCO
LOS ANGELES
SAN DIEGO
San Diego Aqueduct
TO LOS ANGELES
RIVERSIDE COUNTY
ORANGE COUNTY
SAN DIEGO COUNTY
LOWER BASIN
UPPER BASIN
RANCHO
TEMECULA CANYON
DE LUZ HEIGHTS MUNICIPAL WATER DISTRICT
De Luz
DE LUZ RESERVOIR SITE
FALLBROOK RESERVOIR SITE
EXPORT SEWER
CAMP JOSEPH H. PENDLETON U.S.M.C.
Fallbrook
ALTERNATE ROUTE TO MISSION BASIN FOR EXPORT SEWER
FALLBROOK PUBLIC UTILITY DISTRICT
Bonsall
PACIFIC OCEAN
Santa Margarita River
Santa Margarita Lagoon
Ocean Outfall
Oceanside
Temecula Creek
Murrieta Creek
Warm Springs Creek
Temecula
Coahuila
Coahuila Creek
Vail Lake (Existing)
10,000 0 10,000 20,000 30,000
SCALE IN FEET
N
SANTA MARGARITA PROJECT
LOCATION AND STUDY AREA
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
PACIFIC SOUTHWEST REGION SAN FRANCISCO, CALIF.

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FIGURE 1